

REMARKS

Applicants have filed the present Amendment in response to the Office Action mailed August 18, 2003. Claims 1-33, 35-42 and 44-127 are pending in the application. Claims 1-17, 19-33, 35, 36, 40-42, 44-69, 75-121 and 124-127 stand rejected under 35 U.S.C § 103(a) as being unpatentable over the principal reference Carnahan et al., U.S. Patent No. 5,420,424 ("Carnahan '424").

Applicants have submitted a supplemental Information Disclosure Statement ("IDS") herewith. Entry of the IDS and consideration of the new art is respectfully solicited. The new prior art references include:

- Guevremont et al., U.S. Patent No. 6,621,077, issued September 16, 2003 ("Guevremont '077"); and
- Javahery and Thomson, "A Segmented Radiofrequency-Only Quadrupole Collision Cell for Measurements of Ion Collision Cross Section on a Triple Quadrupole Mass Spectrometer," (J. Am. Soc. Mass Spectrom. 1997, p. 697-702) (the "Javahery Publication").

Applicants have amended the claims, in view of the prior art, to address the outstanding rejections and to claim novel, non-obvious and patentable subject matter. Claims 28, 35, 40, 54, 69, 82-118 and 126 have been cancelled. New claims 128-181 have been added. Claims 1, 70, 119, 142, 171, 173, 174 and 181 are in independent format, and the balance of the remaining claims depend variously therefrom. No new matter has been introduced. Reconsideration is respectfully requested.

This amendment proceeds in the following sections:

A. FAIMS AND THE PRESENT INVENTION

B. PRIOR ART OF RECORD AND THE CLAIMED INVENTION

A. FAIMS AND THE PRESENT INVENTION

The present invention is directed to improvements in high field asymmetric waveform ion mobility spectrometry (FAIMS), also known as differential ion mobility spectrometry (DMS).

In FAIMS, ion mobility is represented by a non-constant high field mobility term, and ion filtering is performed in a compensated high-low varying asymmetric RF filter field developed transverse to the ion flow path. Ion species in a sample are separated based on the compound-dependent differences in ion mobility of ions in the high and low field conditions of the FAIMS filter field.

The FAIMS filter field is established between filter electrodes transverse to the ion flow path. The filter field tends to disperse the ions in the flow path such that these ions will drive into the filter electrodes and will be intentionally neutralized, except for the effect of compensation that is applied to the filter field that returns an ion species of interest toward the center of the flow path. This species of interest then passes through the ion filter and is detected and identified.

In a typical prior art FAIMS system, ions are transported along the flow path by a flow of carrier gas. This ion propulsion, or ion transport, is essential for carrying the ions into and through the FAIMS filter field.

The Claimed Invention

The claimed invention provides improvements in electric field ion transport (also known as “ion propulsion”) in various FAIMS configurations.

For the record, the present application is a continuation-in-part of parent U.S. Patent No. 6,512,224 to Miller et al. (“Miller ’224”), which in turn is a continuation-in-part of grandparent U.S. Patent No. 6,495,823 to Miller et al. (“Miller ’823”).

The grandparent Miller ’823 teaches novel compact and efficient FAIMS devices some of which are improved in the parent Miller ’224 which uses electric field ion transport. This electric field ion transport is a desirable improvement. One benefit is the ability to reduce or eliminate use of carrier gas for ion transport in a FAIMS device. Carrier gas adds complexities to the ionization chemistry. Use of a carrier gas also requires having a gas source and a flow

mechanism (such as a pump); the latter adds weight and expense to a FAIMS device. Reduction or elimination of carrier gas is therefore laudable.

Furthermore, in other configurations of the invention, electric field ion transport reduces or eliminates use of carrier gas and can be implemented in a manner that achieves reduction in package size and reduction of power usage. This is very important for cost reduction and improved efficiency and portability in a FAIMS system.

Support in the Specification

Illustrative configurations of the present invention are shown in Fig. 6 and Fig. 7 in the Specification. The invention can provide FAIMS systems with compact packaging while providing electric field ion transport. Devices of the invention can be operated with reduced use of carrier gas or even no carrier gas at all.

Some embodiments of the invention enable extreme device miniaturization. The present invention is able to provide a “packaged FAIMS spectrometer ...reduced in size to perhaps one inch by one inch by one inch.” (Specification, page 18, lines 7-8.) This contrasts sharply with the bulky concentric cylindrical devices of either the cited Carnahan '424 or the newly referenced Guevremont '077.

Preferred embodiments of the invention feature a tightly integrated, compact and efficient FAIMS system that benefits from components serving multiple functions, such as housing, support, spacing, operational, etc. For example, as described in the Specification:

Embodiments of the invention are compact with low parts count, where the substrates and spacers act to both contain the flow path and also to for a structural housing of the invention. Thus the substrates and spacers serve multiple functions, both for guiding the ions and for containing the flow path. (Specification, page 17, lines 22-25.)

In operation of illustrative embodiments of the present invention, ions are transported through the FAIMS ion filter by an electric ion transport field. FAIMS ion filtering is performed in the ion filter, by means of which an ion species is selected (per the applied compensation) and is then transported out of the filter by the electric field. As stated in the Specification, this ion transport is enabled:

by incorporation of an ion flow generator which creates a longitudinal electric field in the direction of the intended ion travel path to propel the ions toward a detector region after passing through a transversely directed asymmetric electric field which acts as an ion filter. (Specification, page 7, lines 12-15.)

The result is an improved FAIMS device with reduced power requirements, in a compact packaging. For example, pumps 14, 14a “can be made smaller or even eliminated in practice of the invention.” (Specification, page 7, lines 8-11.) Operating efficiency improves on the one hand, while packaging improvements enable a more compact FAIMS system on the other hand. (Compare the large cylindrical device of Carnahan '424 or Guevremont '007 to the compact packaging of the present invention as illustrated in FIGs. 6-7.)

The ion propulsion field (i.e., ion transport) is generated between propulsion electrodes associated with the flow path. These can be discrete, continuous, or segmented. In some embodiments, these propulsion electrodes are formed as resistive layers (e.g., FIG. 12).

As taught in the present specification, ion transport electrodes and filter electrodes can be separate or integrated. According to the invention, a first voltage can be applied to create the filter field and then a second voltage can be applied to “other or same electrodes to generate the longitudinal ion transport field....” (Specification page 25, line 26 - page 26, line 2.)

In another embodiment of the present invention, a traveling wave voltage, expressed as: $V \cos(\omega t - kz)$, where $k = 2\pi/\lambda$ is the wave number, has an associated electric field with both transverse and longitudinal components. Ion propulsion is achieved wherein succeeding sets of opposed electrodes are excited by a voltage source at a fixed phase difference from the voltage source applied to the adjacent set of opposing electrodes. (Specification, page 26, lines 13-23.)

In yet another embodiment of the present invention, electrodes cooperate to produce an electrical field or fields. The net effect provides both transverse and longitudinal field components to both filter and propel the ions. (Specification page 26, line 13 - page 27, line 18.) In another embodiment, ion filtering with electric field ion transport is achieved without the need for filter field compensation. (Specification, page 27, lines 13-23.)

Novel and non-obvious embodiments of the invention are set forth in the claims, as amended. Language of the claims that distinguishes over the prior art is discussed below.

B. PRIOR ART OF RECORD AND THE
CLAIMED INVENTION

The following discussion demonstrates novel and non-obvious claims. Furthermore, it will be shown that:

- 1) the references teach away from FAIMS devices that do not use concentric cylindrical electrodes, and therefore do not make obvious the non-concentric cylindrical FAIMS innovations with electric field ion transport of twice amended Claim 70;
- 2) the references fail to teach a compactly packaged FAIMS configuration with electric field ion propulsion, and therefore do not make obvious the special FAIMS configurations with electric field ion propulsion of twice amended Claim 1 and of new Claim 142 or the method of same in new Claim 174; and
- 3) the references fail to teach any FAIMS system with electric field ion propulsion with a phased propulsion function as in amended Claim 119, resistive propulsion layers as in new Claim 171, non-segmented propulsion electrodes as in new Claim 173, or electric field ion transport and a segmented detector that avoids the need for filter field compensation as in new Claim 181.

1. Non-Concentric Cylindrical Innovations As In Claim 70

FAIMS technology has been promoted, among other reasons, because it enables gas analysis involving direct sampling of the ambient atmosphere. This technology was first introduced by Buryakov et al. (of record), using “plate-type” filter electrodes (i.e., not concentric cylindrical electrodes).

Subsequently, Carnahan '424 featured FAIMS with concentric cylindrical electrodes. In Carnahan, et al., “Field Ion Spectrometry - A New Analytical Technology For Trace Gas Analysis,” © ISA, 1996 Paper #96-009 (pages 87-96) (the “Carnahan Publication”; of record), the authors expressed the opinion that only concentric cylindrical FAIMS systems were fit for practical gas analysis (as in Carnahan '424 or Guevremont '077). Specifically, the Carnahan Publication described plate-type FAIMS devices as:

...unsuitable for practical gas analysis applications which involves direct sampling of the ambient atmosphere. The reason is that the same stream that is drawn into the analyzer as a sample is also used to transport the ion through the spectrometer. [The]... resulting effective neutralization of the ions of interest will render the analyzer incapable of detecting them. (the Carnahan Publication at page 91; Emphasis added.)

Guevremont '077 supported the Carnahan “unsuitable” teaching, while promoting the concentric cylindrical FAIMS electrode design. As stated in Guevremont '077, “Carnahan et. al. improved the sensor design by replacing the flat plates used to separate the ions with concentric cylinders.” (Col. 7, lines 20-31; Emphasis added.)

Both Carnahan and Guevremont, promoted concentric cylindrical FAIMS designs and thought all others were “unsuitable.” But Carnahan’s and Guevremont’s teachings of using concentric cylindrical FAIMS and rejecting plate-type (i.e., non-concentric cylindrical) FAIMS as “unsuitable for practical gas analysis,” were incorrect and continue to be incorrect.

In fact, the grandparent Miller '823 and parent Miller '224 pushed against this contrary teaching of Carnahan and Guevremont and opened up a whole improved area of FAIMS devices. The Miller et al. innovations demonstrated that FAIMS devices with non-concentric cylindrical electrodes were indeed suitable for practical gas analysis applications which involves direct sampling of the ambient atmosphere. Favorable results are reported in Miller '823 and '224 and in later articles. The present invention builds on the success.

For the record, some of the present claims address FAIMS with specific electrode configurations while others of the claims are broader. Thus, some embodiments of the claimed invention apply generally to FAIMS (whether the electrodes are plate-type, concentric, non-concentric, cylindrical, or otherwise), while other embodiments are directed to specific electrode configurations (e.g., non-concentric, resistive, segmented, etc.).

In any event, the mere use of the electric field ion transport of the invention eliminated the Carnahan “unsuitable” teaching quoted above that had apparently been the driving force in prior art favoring concentric cylindrical over other electrode designs. Carnahan reached this conclusion by reasoning that the same stream that is drawn into the analyzer as a sample is also used to transport the ion through the spectrometer. But the use of the electric field ion transport

eliminates this same stream problem because the carrier stream transport is not needed when using electric field transport.

Prior to the present invention, no one saw that using electric field ion transport would mean that the “stream that is drawn into the analyzer as a sample” would NOT be “used to transport the ion through the spectrometer” (to paraphrase Carnahan). Rather the ions are transported predominantly or exclusively by electric field in the present invention. The gas flow is no longer there to present Carnahan’s “unsuitable” problem.

Therefore the devices of the invention do not suffer from a “resulting effective neutralization of the ions of interest” as Carnahan stated. To the contrary, devices of the claimed invention with electric field ion propulsion are very capable of ion detection.

The inventors of the presently claimed invention rejected the incorrect teachings of Carnahan and Guevremont. Given this persistence and insight, it is impossible to say that the present innovations were obvious. The presently claimed innovations went contrary to current thought. Certainly they were not obvious.

Claim 70

Independent Claim 70 is directed to novel and non-obvious, non-concentric cylindrical FAIMS with electric field ion transport, quite to the contrary of these authorities. As a matter of fact and law, the prior art teaches away from, or do not teach at all, the innovations of objected to Claim 70, as amended.

Objected to Claim 70, as amended, now incorporates the language of base claim 69 (canceled), in allowable format. Independent Claim 70 is now patentably directed to an asymmetric field ion mobility spectrometer (FAIMS) apparatus with a flow path for the flow of ions in a longitudinal direction from an ionization region toward a detector region. An ion filter is provided in the flow path downstream from the ionization region, with the ion filter disposed in the flow path and supplying an asymmetric field transverse to the flow path.

An ion flow device creates a longitudinal transport field for propelling ions in the filter longitudinally along the flow path. The asymmetric field is transverse to the ion flow in the flow path. The ion filter pass ions toward the detector region as influenced by the transverse

asymmetric field and as propelled by the transport field. The ion filter is for connecting to an electric control source for applying the asymmetric periodic voltage to the ion filter.

The ion filter includes a pair of spaced electrodes for creating a compensated asymmetric electric field and the ion flow device includes a plurality of spaced electrodes for creating the longitudinal field, “wherein the spaced electrodes are not concentric cylinders”; and wherein the electrodes of the pair of spaced electrodes are separated by an analytical gap, the flow of ions flowing in the gap according to the transport field, and the flow of ions in the gap being filtered according to aspects of ion mobility in the compensated asymmetric electric field.

There is clearly no teaching of the innovation of Claim 70 in any of the prior art or combination thereof. Therefore, Applicants respectfully submit that Independent Claim 70 is in condition for allowance. Dependent Claims 71-81, 125, and 166, 168, as amended, further patentably define the apparatus of Claim 70. Therefore allowance of these claims, as amended, is respectfully solicited.

2. Compactly Packaged FAIMS Configurations With Electric Field Ion Transport As In Claims 1, 142, And 174

Notwithstanding the foregoing, there is additional basis for finding novelty and non-obvious invention. In another aspect of the invention, special novel and non-obvious packaging configurations, as in Claims 1 and 142 and the method of Claim 174 provide low parts-count FAIMS devices in compact packages while utilizing electric field ion transport. The result in each case is a streamlined and compact FAIMS system, such as illustrated (without limitation) in FIGs 6-7 of the Specification.

A. The references do not teach meaningful electric field ion transport in a compact and practical FAIMS system.

Carnahan '424 uses carrier gas to convey ions. It is not relevant to any of the claimed embodiments of the invention. The carrier gas enters at the sample input end of the flow path and flows axially, carrying gas-phase ions to the FAIMS ion filter and carrying selected ion species out of the filter to a downstream detector.

Guevremont '077 FIGs 1-22 teaches the same carrier gas ion transport in concentric cylindrical FAIMS systems as in Carnahan '424. But Guevremont '077 also speculates that an

electric field might be used to provide ion propulsion in a segmented concentric cylindrical FAIMS device; this is based on teachings of the Javahery Publication. However, this speculation fails miserably upon further inspection.

The totality of this speculation is made in Guevremont '077 in one paragraph:

Now referring to FIG. 23, it is possible to visualize the transport of ions in FAIMS using electric fields. A possible embodiment would require that the FAIMS unit be segmented, much in the same way that ... [the Javahery Publication] used a segmented rf-only quadrupole to create a longitudinal electric field to draw ions along the length of a set of quadrupole rods which were operating with the usual applied high frequency, high voltage ac voltage applied to them. The segments in either the case of segmented quadrupole rods, or FAIMS, are held at slightly different dc potentials, which creates a field superimposed on the other non-constant fields. A possible way to do this is shown in FIG. 23. (Col. 35, lines 25-38 and as shown in Fig. 23; Emphasis added.)

This one figure, one paragraph, and the reference to Javahery Publication is the full extent of speculation as to the use of electric field ion transport in FAIMS in Guevremont '077. This speculation does not teach the presently claimed invention. Such speculative disclosure of Guevremont is totally inadequate to teach a practical or viable FAIMS implementation of electric field ion transport, such as set forth in Claims 1, 142 or 174.

B. Combination of Javahery with FAIMS results in an unworkable device.

The Javahery Publication shows a modified collision cell within the flow path of a triple quadrupole mass spectrometer. The collision cell is modified to consist of ten short quadrupole rod segments that allow an axial field to be applied to the cell in order to make measurements of ion mobility. An RF-quadrupole field is provided to assure "radial confinement that greatly reduces diffusional losses at low pressure." The net result is an RF quadrupolar field which confines the ions in the radial direction and a dc field which moves the ions in the axial direction. The cell is pressurized with 8×10^{-3} torr of nitrogen. The ions are gated into the cell and subjected to the RF quadrupolar field.

C. Combination of the Javahery device with any prior art FAIMS system would be a problem.

The Javahery RF field provides a “radial confinement.” Therefore all ion species would be retained mid-flow. This is exactly contrary to the teaching and function of FAIMS. There would NOT be any FAIMS filtering if this reference were added to any prior art FAIMS device because in FAIMS ions must be able to travel radially in the filter and contact the filter electrodes where they are intentionally neutralized except for the ion species that compensation permits to remain in the center of the flow. Javahery would keep all of the ions mid-flow without any FAIMS filtering.

In the present invention, unlike Guevremont-Javahery, ions are intentionally driven radially toward the electrodes to be neutralized by contact with the electrodes except for ions that return to the center of the flow path according FAIMS principles. This is an essential part of FAIMS filtering. Javahery’s radial confinement would make it impossible to provide a functional FAIMS filter.

Furthermore, FAIMS systems operate continuously at atmospheric pressure. In Javahery, ions are gated into a system with pressurization of 8×10^{-3} torr of nitrogen. This is approximately one million times lower pressure than the operating environment of any prior art FAIMS system.

Therefore Guevremont '077 in combination with the Javahery Publication clearly fails to teach meaningful electric field ion transport in a FAIMS system and fails as prior art.

In practice of the present invention, a simplified package with enclosed flow path enables structure with a functional electric field ion transport in a compact FAIMS device where ions are intentionally RF-dispersed and neutralized by contact with the filter electrodes except for the species that the RF field compensation keeps flowing midstream through the filter. Nothing of this sort is taught in any of the prior art.

Claim 1

Independent Claim 1 is directed to novel and non-obvious FAIMS device in which an ion flow part is provided for propelling the flow of ions along the flow path and in the ion filter via a propulsion field. The claimed device has a filter for supplying an asymmetric filter field for filtering ions by species in which the filter field is compensated to pass a selected ion species through the filter. Thus, unlike Guevremont or Javahery, all the ions that are not compensated will be intentionally neutralized by contact with the filter electrodes. This device further has a support structure that defines an enclosed flow path in a defined ion filter part, with an enclosed ion filter that includes spaced apart filter electrodes in the ion filter part for formation of the compensated filter field. The filter electrodes are separated from each other by the support structure in the ion filter part. The result is a compactly defined FAIMS system with electric field ion transport. Nothing like this packaged FAIMS innovation is taught or suggested in the prior art.

There clearly is no teaching of the innovation of twice amended Claim 1 in any of the prior art or combination thereof. Therefore, Applicants respectfully submit that Independent Claim 1 is in condition for allowance. Dependent Claims 2-27, 29-33, 36-39, 41-42, 44-53, 55-68, 124, 128-141, and 167, as amended, further patentably define the apparatus of Claim 1. Therefore allowance of these claims, as amended, is respectfully solicited.

Claim 142

Independent Claim 142 is directed to novel and non-obvious FAIMS having a plurality of electrodes associated with the flow path, including filter electrodes, and also including propulsion electrodes for generating a propulsion field for propelling the ions in the ion filter. This is achieved in a structure in which electrodes are integrated into an enclosure and the enclosure acts to separate, support and insulate the filter electrodes, to define the gap separating the electrodes, and to enclose the sides of the flow path in the region of the ion filter. Nothing like this compact innovation is taught in the prior art.

There is clearly no teaching of the innovation of new Claim 142 in any of the prior art or combination thereof. Therefore, Applicants respectfully submit that Independent Claim 142 is in condition for allowance. Dependent Claims 143-164 and 170 further patentably define the

apparatus of Claim 142. Therefore allowance of these claims, as amended, is respectfully solicited.

Claim 174

Independent Claim 174 is directed to a novel and non-obvious method for providing a FAIMS filter with a flow path having a longitudinal axis for the flow of ions, the filter supplying an asymmetric filter field transverse to the longitudinal axis for filtering ions in the flow of ions by species. The filter field is compensated to pass a selected ion species from the flow of ions through the filter. The flow path has an input part, an output part, and an ion filter part for containing the ion filter. The method further provides a support structure with a plurality of supported electrodes associated with said flow path, with the supported electrodes including spaced filter electrodes spaced apart by the support structure in the ion filter part. The spaced apart filter electrodes are separated by an analytical gap for forming the ion filter.

The method includes providing an electrical input for driving the ion filter and generating the asymmetric filter field in the gap, and providing an ion flow part for propelling the flow of ions along the flow path from the input part along the ion filter part and toward the output part.

The ion flow part propels ions via a propulsion field, and the propelled ions flow in the filter accordingly. By defining an enclosed flow path in the ion filter part, it provides support structure defining an enclosed ion filter including spaced apart filter electrodes. These filter electrodes are separated from each other by the support structure in the filter.

The method also includes selecting a species of propelled ions flowing in the filter, wherein the selected species is passed by the filter and has at least one characteristic correlated with the compensated asymmetric filter field, wherein this correlation facilitates identification of the selected and passed ion species. There is no teaching of a method as contemplated in Claim 174, and depending claims 175-180.

There is clearly no teaching of the innovation of new Claim 174 in any of the prior art or combination thereof. Therefore, Applicants respectfully submit that Independent Claim 174 is in condition for allowance. Dependent Claims 175-180 further patentably define the method of Claim 174. Therefore allowance of these claims, as amended, is respectfully solicited.

3. Configurations Having Electric Field Ion Transport With Phased Propulsion Function As In Claim 119, Or Resistive Propulsion Layers As In Claim 171, Or Non-Segmented Propulsion Electrodes As In Claim 173, Or Filter With Segmented Detector and Ion Propulsion Field As In Claim 181.

Additional FAIMS configurations as taught in the specification are set forth in Claims 119, 171, 173, and 181.

Claim 119

Independent Claim 119 is directed to novel and non-obvious FAIMS design that propels ions by means of a propulsion function set up between propulsion electrodes that provides low parts-count FAIMS devices in an enclosed package while utilizing electric field ion transport. For example see the embodiment of FIG. 17 of the invention.

In amended Claim 119, among other features, an enclosed flow path is defined by a structure including a plurality of separate electrodes, with selected ones of the electrodes being separated from each other by the structure and transversely between them defining an analytical gap in the enclosed flow path. An ion filter is disposed in the gap downstream from an ionization source, in which an asymmetric electric field is presented to filter the ions. An ion flow propulsion generator is provided for creating an electric field transverse to the asymmetric electric field in the filter in the gap for propelling ions through the asymmetric electric field. The plurality of electrodes includes electrodes driven by the propulsion generator according to a phased ion propulsion function.

There is no showing of such phased function in the FAIMS package of Amended Claim 119 in any prior art. Dependent Claims 120-123, 127, 165, and 169 further patentably define the invention. Therefore allowance of these claims, as amended, is respectfully solicited.

Claim 171

Independent Claim 171 is directed to novel and non-obvious FAIMS apparatus with an ion flow device that includes facing resistive layers for generating the ion transport field. The device has a flow path for the flow of ions from an ionization region toward a detector region, with an ion filter disposed in the flow path downstream from the ionization region, the ion filter

disposed in the flow path and supplying an asymmetric field transverse to the flow path and an ion flow device for creating a longitudinal transport field for propelling ions in the filter along the flow path. The asymmetric field is transverse to the ion flow in the flow path and the ion filter passes ions toward the detector region as influenced by the transverse asymmetric field and as propelled by the transport field. An electric control source applies an asymmetric periodic voltage to the ion filter, wherein the ion filter includes a pair of spaced electrodes for creating a compensated asymmetric electric field. The ion flow device includes facing resistive layers for generating the ion transport field, wherein the electrodes of the pair of spaced electrodes are separated by an analytical gap. The flow of ions flows in the gap according to the transport field and the flow of ions in the gap is filtered according to aspects of ion mobility in the compensated asymmetric electric field.

There is no showing in any prior art of such facing resistive layers, etc., as in the claimed device of new Claim 171. Dependent Claim 172 further patentably defines the invention. Therefore allowance of these claims is respectfully solicited.

Claim 173

Independent Claim 173 is directed to novel and non-obvious apparatus wherein the propulsion electrodes are not segmented. More particularly, a flow path is provided for the flow of ions from an ionization region toward a detector region; an ion filter is disposed in the flow path downstream from the ionization region, the ion filter disposed in the flow path and supplying an asymmetric field transverse to the flow path; an ion flow device is for creating a longitudinal transport field for propelling ions in the filter along the flow path; the asymmetric field being transverse to the ion flow in the flow path and the ion filter passing ions toward the detector region as influenced by the transverse asymmetric field and as propelled by the transport field. An electric control source is for applying an asymmetric periodic voltage to the ion filter, wherein the ion filter includes a pair of spaced electrodes for creating a compensated asymmetric electric field and the ion flow device includes a plurality of spaced electrodes for creating the transport field. The propulsion electrodes are not segmented (unlike the rings of Guevremont '077) and wherein the spaced electrodes are separated by an analytical gap, the flow of ions

flowing in the gap according to the transport field, and the flow of ions in the gap being filtered according to aspects of ion mobility in the compensated asymmetric electric field.

There is no showing in any prior art of such non-segmented arrangement, as in Claim 173. Therefore allowance of this claim is respectfully solicited.

Claim 181

Independent Claim 181 is directed to novel and non-obvious apparatus featuring an enclosed flow path defined by a structure including a plurality of electrodes with electrodes separated from each other by the structure and transversely between them defining an analytical gap in the enclosed flow path. The ionization source enables delivery of ions from an ionized sample to the analytical gap. An ion filter in the analytical gap downstream from the ionization source is for creating a high-low varying asymmetric RF field (i.e., a FAIMS RF field) to filter the ions in the analytical gap. The ion filter further defines a segmented ion detector having segmented detector electrodes. An ion propulsion generator is provided for creating an electric field transverse to the RF filter field and along the flow path for propelling ions in the analytical gap, each ion obtaining a trajectory according to its species, and the ion detector detecting these ion species as the ions contact the detector segments according to each ion's trajectory.

There is no structure of this sort that is either taught or suggested by any of the prior art. Therefore allowance of new Claim 181 is respectfully requested.

CONCLUSION

The prior art fails to teach or suggest the present invention. The references do not teach the FAIMS improvements of the invention, including apparatus with electric field ion propulsion in the packaging and support structure of Claim 1, apparatus with packaged electrodes of Claim 70, spectrometer with enclosed flow path structure with electric field ion propulsion function of Claim 119, system with multi-functional enclosure with electric field ion propulsion of Claim 142, apparatus with electric field ion propulsion with resistive layers of new Claim 171, apparatus with non-segmented electric field ion propulsion electrodes of new Claim 173, method of achieving a compact FAIMS filter of Claim 174, and spectrometer with a trajectory FAIMS arrangement with electric field ion transport using a segmented detector as in Claim 181.

It is respectfully submitted that the presently claimed invention of amended independent Claims 1, 70, or 119, or new Claims 142, 171, 173, 174 or 181 is neither shown, taught nor suggested in any known prior art, either alone or in any reasonable combination thereof.

It is respectfully submitted that the specification fully supports the claims, as amended, and that the claims, as amended, are directed to disclosed embodiments and comprise all elements essential to a person skilled in the art to practice of the invention. No new matter has been added.

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a teleconference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,


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